CLAIMS

What is claimed is:

1. A method of communicating a plurality of signals that have been coherently multiplexed together over an optical link from a first site, the method comprising the steps of:

operating a light source unit to produce multiple mutually coherent outputs which are directed as optical signals into a plurality of optical paths comprising "N" signal paths and a reference path;

wherein each of the "N" signal paths form one of "N" signal arms of "N" interferometers, the reference path forms the reference path arm for each interferometer, and the path length difference of each interferometer is ΔL_i;

wherein each of the "N" signal paths have a modulator therein which receives optical signals and modulates the received optical signals with data; and,

combining the optical signals from each of the "N" signal paths and from the reference path to generate a combined optical signal that is transmitted on a single optical path.

2. The method of Claim 1, further comprising the steps of:

optically splitting the combined signal into "N" optical signals on "N" path pairs at a second site, wherein each path pair forms an interferometer with two inputs and two outputs, and the path length difference of each interferometer is ΔL_i', and

coherently demultiplexing each of the "N" optical signals to retrieve the data through differential detection of the two outputs of each interferometer.

3. The method of Claim 1, wherein the light source unit comprises a phase locked laser diode array.

4. The method of Claim 3, wherein the light source unit includes an imaging system.

5. The method of Claim 4, wherein the imaging system comprises a microlens array.

6. The method of Claim 4, wherein the imaging system comprises a cylindrical lens.

7. The method of Claim 1, wherein the light source unit comprises a phase locked light-emitting diode array.

8. The method of Claim 7, wherein the light source unit includes an imaging system.

9. The method of Claim 1, wherein the light source unit produces a singular output which is imaged into multiple optical fibers.

10. The method of Claim 1, wherein the light source unit produces a singular output which is imaged into multiple integrated optical waveguide channels by an imaging system.

11. The method of Claim 10, wherein the imaging system comprises a microlens array.

12. The method of Claim 10, wherein the imaging system comprises a cylindrical lens.

13. The method of Claim 1, wherein the light source unit comprises a single source that feeds a 1x2 coupler, one output of the coupler feeds a common reference path (r) for "N" interferometers and the other output of the coupler feeds a 1xN splitter that feeds "N" signal paths comprising the second arms of the "N" interferometers.

14. The method of Claim 13, wherein "N" is greater than or equal to 3.

15. The method of Claim 1, wherein a frequency modulator is placed in the reference path to shift the reference frequency.

16. The method of Claim 1, wherein the path length differences of each of the "N" interferometers $\Delta L_i = [n + 2n(i-1)]L_{coh}$, where "n" is a number to be determined by a global system performance analysis.

17. The method of Claim 1, wherein the modulator uses amplitude (ASK) modulation.

18. The method of Claim 1, wherein the modulator uses phase (PSK) modulation.

19. The method of Claim 1, wherein the modulator uses frequency (FSK) modulation.

20. A method of communicating a plurality of signals over an optical link from a first site, the method comprising the steps of:

multiplexing at the first site “M” signals to produce a single multiplexed signal, wherein at least one of the “M” signals has been coherently multiplexed; and,

optically transmitting a multiplexed signal to a second site.

21. The method of Claim 20, wherein the step of multiplexing includes wavelength division multiplexing.

22. The method of Claim 20, further comprising the steps of:

demultiplexing at a second site the multiplexed signal into “M” signals, and

directing at least one of the “M” signals to a coherent demultiplexing unit.

23. The method of Claim 22, wherein the step of demultiplexing includes wavelength division demultiplexing.

24. The method of Claim 20, further comprising the step of spectrally slicing the output of a broadband light source into “M” separate outputs having different wavelengths.

25. The method of Claim 24, wherein the broadband light source comprises a mode-locked laser source.

26. The method of Claim 24, wherein the broadband light source comprises a fiber amplifier.

27. The method of Claim 24, wherein the broadband light source comprises an amplified spontaneous emission source.

28. The method of Claim 24, wherein the step of spectrally slicing comprises wavelength division demultiplexing.

29. A method of receiving a plurality of optical signals that have been coherently multiplexed together and transmitted over an optical link from a first site to a second site, the method comprising the steps of:

receiving an optical signal;

optically splitting the received signal into "N" optical signals on "N" path pairs, wherein a single path pair forms an interferometer comprising two arms having different path lengths (ΔL_i');

coherently demultiplexing the "N" optical signals.

30. The method of Claim 29, wherein the step of coherently demultiplexing is performed using a coherent demultiplexer matched to a coherence multiplexer so that $|\Delta L_i - \Delta L_i'| < L_{coh}$.

31. The method of Claim 30, wherein the optical signals on each path are separated in path length from each other by a distance of at least $n L_{coh}$, where n is determined by detailed system performance analysis.

32. The method of Claim 29, wherein the step of coherently demultiplexing employs homodyne reception and active path length stabilization.

33. The method of Claim 29, wherein the step of coherent demultiplexing includes polarization splitting of the path of each channel allowing the polarized signals to be directed to two separate demultiplexing interferometers.

34. The method of Claim 29, wherein the step of coherent demultiplexing is performed using a coherence demultiplexer having a coherence receiver therein, and wherein an active polarization adjuster with feedback communicates with the coherence receiver.

35. The method of Claim 29, wherein the step of coherent demultiplexing is performed using a coherence demultiplexer having an interferometer, and wherein an active polarization adjuster with feedback is placed in one path of the interferometer.

36. The method of Claim 29, wherein the step of coherent demultiplexing is performed using a coherence demultiplexer having an interferometer, and wherein a frequency modulator is placed in one path of the interferometer.

37. The method of Claim 29, wherein the step of coherent demultiplexing is performed using a coherence demultiplexer using heterodyne reception.

38. The method of Claim 37, wherein the step of coherent demultiplexing is performed using a coherence demultiplexer having an interferometer, and wherein active path length stabilization is used on one of the paths of the interferometer.

39. A method of communicating a plurality of signals over an optical link from a first site to a second site, the method comprising the steps of:

optically multiplexing the outputs of "M" signals to form a multiplexed signal, wherein at least one of the "M" signals has been coherently multiplexed;

communicating the multiplexed signal to a second site;

optically demultiplexing the multiplexed signal at the second site into "M" optically demultiplexed signals;

delivering the "M" optically demultiplexed signals to at least one coherent demultiplexer; and

optically splitting the "M" optically demultiplexed signals into "N" optical signals on "N" path pairs, wherein a single path pair forms an interferometer including two arms having different path lengths (ΔL_i'), wherein the two arms include a signal path carrying a data signal and a reference path carrying a reference signal;

recombining the data signal and the reference signal to produce a recombined signal; and

communicating the recombined signal to a coherence receiver having two light source detectors connected to a differential amplifier.

40. The method of Claim 39, wherein each coherence demultiplexer is matched to a coherence multiplexer so that $|\Delta L_i - \Delta L_i'| < L_{coh}$.

41. The method of Claim 40, wherein the optical signals on the signal path and the reference path are separated in path length from each other by a distance of at least $n L_{coh}$, where n is determined by detailed system performance analysis.

42. The method of Claim 39, wherein each coherence demultiplexer includes a coherence receiver using homodyne reception and active path length stabilization.

43. The method of Claim 39, wherein the step of optically splitting includes polarization splitting of each path of each channel.

44. The method of Claim 39, further comprising a step of adjusting the polarity of the reference signal with an active polarization adjuster using feedback.

45. The method of Claim 39, wherein an active polarization adjuster with feedback exists in one path of each interferometer.

46. The method of Claim 39, wherein a frequency modulator is present in one path of each interferometer.

47. The method of Claim 39, wherein the coherence receiver uses heterodyne reception.

48. The method of Claim 47, wherein active path length stabilization is used in one of the paths of the interferometer.

49. The method of Claim 39, further comprising a step of dropping a channel having N coherence multiplexed signals.